CDIO -
CONTEXT AND LEARNING OUTCOMES

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OUTLINE

- Challenges & opportunities for engineering education
- Evolution of engineering education
- Central questions of engineering education
- What is an engineer? What do engineers do?
- The professional role and context of engineers
- The need for a new approach
  - The CDIO goals and vision
  - What do engineering graduates need to be able to do?
  - How can we do better at educating them?
- How to develop a CDIO-based educational program?
- Concluding remarks & discussion

MOTIVATION

Problems

- Multi-disciplinary problems
- Globaliz-ation
- New technologies & services
- Sustain-able solutions
- Entre-preneurship

Skills

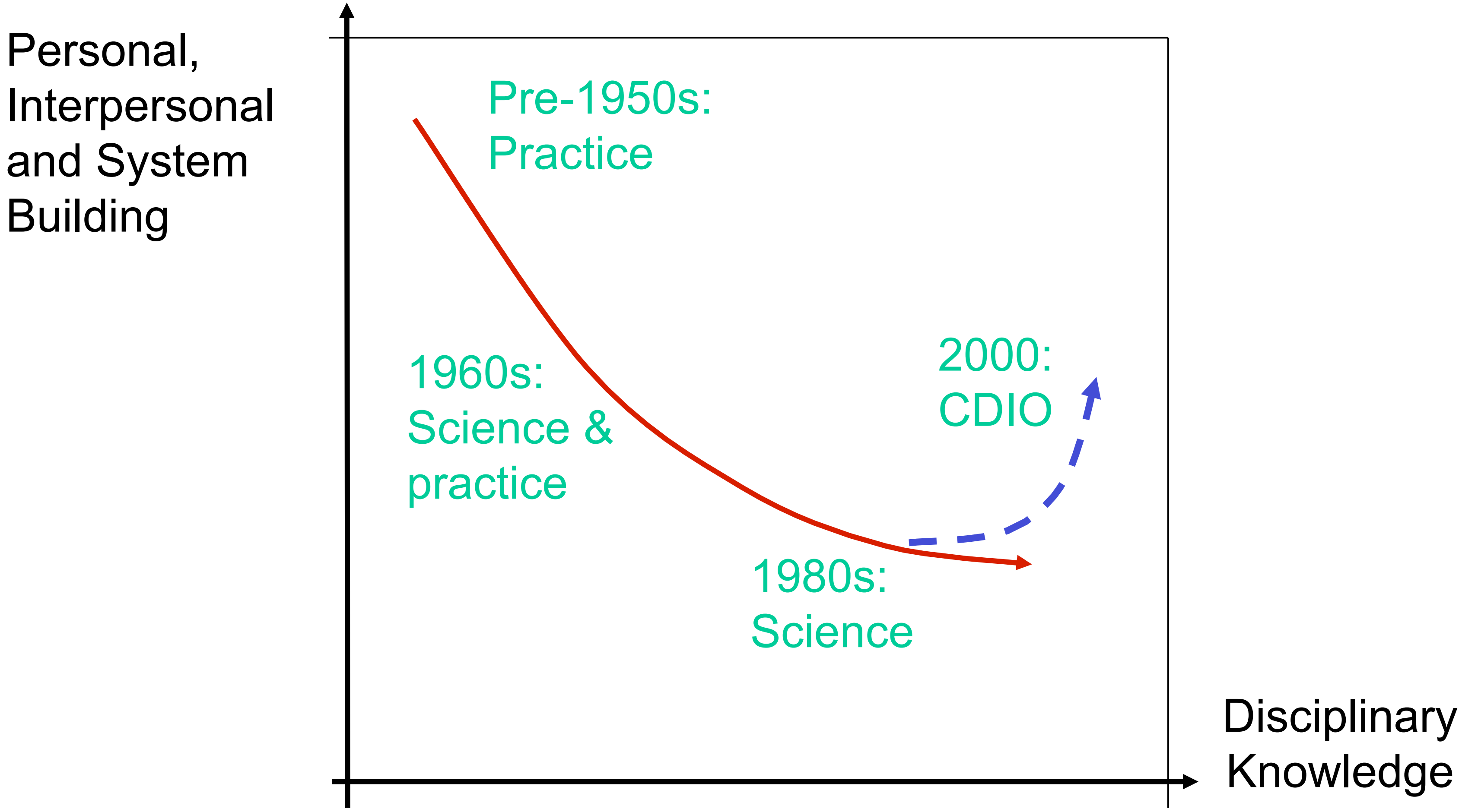
- Design & Innovation
- Communicatio n & teamwork
- Personal skills

Constraints & resources

- Prior knowledge
- Faculty competence & time
- E-learning tools
- Digital engineering tools

- **Remarkable similarity across the world!**
- **Opportunity: Through use of pedagogical innovation and worldwide collaboration, educate engineers who can develop a better future**

EVOLUTION OF ENGINEERING EDUCATION



Engineers need *both* dimensions, and we need to develop education that delivers both

CENTRAL QUESTIONS FOR ENGINEERING EDUCATION DESIGNERS

1. <u>What</u> is the professional role and practical context of the profession(al)? (need)

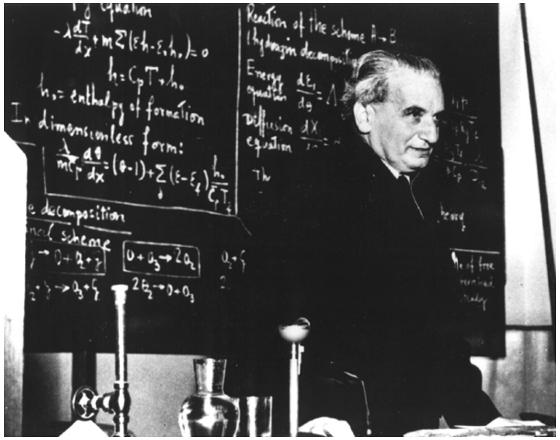
2. <u>What</u> knowledge, skills and attitudes should students possess as they graduate from our programs? (program learning outcomes)

3. <u>How</u> can we do better at ensuring that students learn these skills? (curriculum, teaching, learning, workspaces, assessment)

Massachusetts Institute of Technology

1. THE PROFESSIONAL ROLE OF ENGINEERS

”Scientists investigate that which already is. Engineers create that which has never been.
- Theodore von Karmann



”What you need to invent, is an imagination and a pile of junk”
- Thomas Edison

THE CDIO DEFINITION

”Engineers Conceive, Design, Implement and Operate complex products and systems in a modern team-based engineering environment”

THE C-D-I-O PROCESS

cdio

Lifecycle of a product, process, project, system, software, material

Conceive: customer needs, technology, enterprise strategy, regulations; and conceptual, technical, and business plans

Design: plans, drawings, and algorithms that describe what will be implemented

Implement: transformation of the design into the product, process, or system, including manufacturing, coding, testing and validation

Operate: the implemented product or process delivering the intended value, including maintaining, evolving and retiring the system

Duke University

VISION FOR A CDIO-BASED EDUCATION

An education that stresses the fundamentals, set in the context of Conceiving – Designing – Implementing – Operating systems and products:

- **A curriculum organised around mutually supporting courses, but with CDIO activities highly interwoven**
- **Rich with student design-build projects**
- **Integrating learning of professional skills such as teamwork and communication**
- **Featuring active and experiential learning**
- **Constantly improved through quality assurance process with higher aims than accreditation**

2. WHAT IS THE FULL SET OF KNOWLEDGE, SKILLS AND ATTITUDES THAT A STUDENT SHOULD POSSESS AS THEY GRADUATE FROM UNIVERSITY?

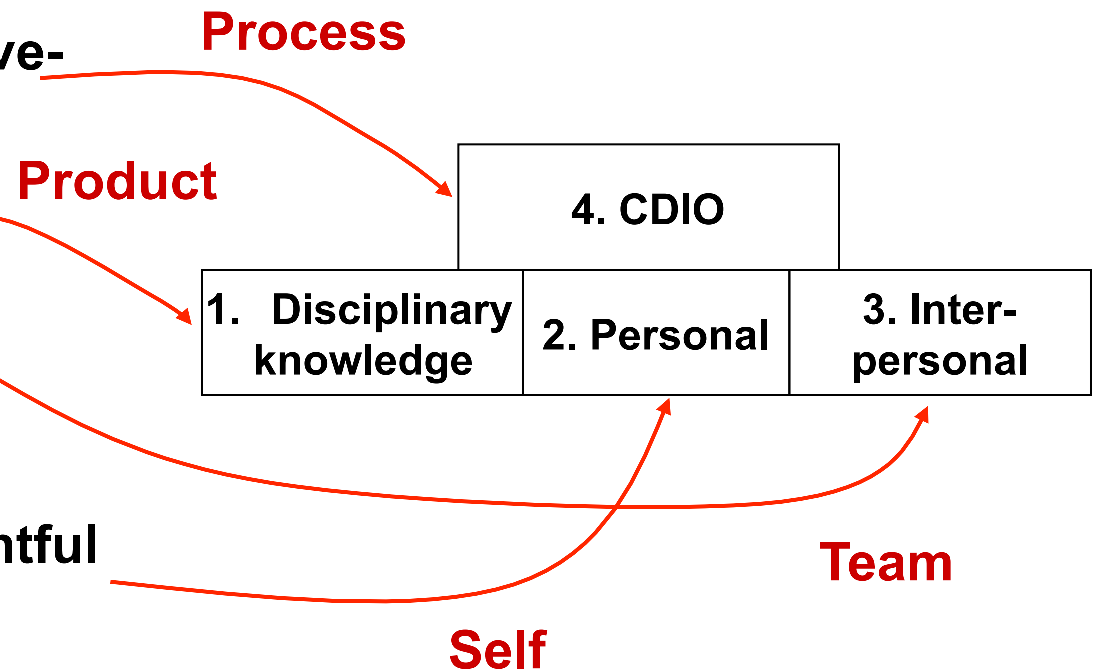
– At what level of proficiency?

– In addition to the traditional engineering disciplinary knowledge

FROM UNDERLYING NEED TO PROGRAM LEARNING OUTCOMES

Educate students who:

- **Understand how to conceive-design-implement-operate**
- **Complex products and systems**
- **In a modern team-based engineering environment**
- **And are mature and thoughtful individuals**



The CDIO Syllabus - a comprehensive statement of detailed <u>goals for an engineering education</u>

THE CDIO SYLLABUS 2.0

- **A generalized list of competences that an engineer should possess**
- **Program specific (1) and general (2-4)**
- **Created and validated by alumni, faculty and students**
- **A "complete" reference model**

1 Disciplinary Knowledge & Reasoning:
1.1 Knowledge of underlying mathematics and sciences
1.2 Core engineering fundamental knowledge
1.3 Advanced engineering fundamental knowledge, methods and tools

2 Personal and Professional Skills
2.1 Analytical reasoning and problem solving
2.2 Experimentation, investigation and knowledge discovery
2.3 System thinking
2.4 Attitudes, thought and learning
2.5 Ethics, equity and other responsibilities

3 Interpersonal Skills
3.1 Teamwork
3.2 Communications
3.3 Communication in a foreign language

4 CDIO of Complex Systems
4.1 External, societal and environmental context
4.2 Enterprise and business context
4.3 Conceiving, systems engineering and management
4.4 Designing
4.5 Implementing
4.6 Operating
4.7 Leadership
4.8 Entrepreneurship

CDIO Syllabus contains 2-3 more layers of detail

CDIO SYLLABUS V 2.0

- **Syllabus at 3rd level of detail**
- **One or two more detailed levels are developed**
- **Basis for course design and assessment**

1 DISCIPLINARY KNOWLEDGE AND REASONING
1.1 KNOWLEDGE OF UNDERLYING MATHEMATICS AND SCIENCES
1.2 CORE ENGINEERING FUNDAMENTAL KNOWLEDGE
1.3 ADVANCED ENGINEERING FUNDAMENTAL KNOWLEDGE, METHODS AND TOOLS

2 PERSONAL AND PROFESSIONAL SKILLS AND ATTRIBUTES
2.1 ANALYTICAL REASONING AND PROBLEM SOLVING
2.1.1 Problem Identification and Formulation
2.1.2 Modeling
2.1.3 Estimation and Qualitative Analysis
2.1.4 Analysis With Uncertainty
2.1.5 Solution and Recommendation
2.2 EXPERIMENTATION, INVESTIGATION AND KNOWLEDGE DISCOVERY
2.2.1 Hypothesis Formulation
2.2.2 Survey of Print and Electronic Literature
2.2.3 Experimental Inquiry
2.2.4 Hypothesis Test and Defense
2.3 SYSTEM THINKING
2.3.1 Thinking Holistically
2.3.2 Emergence and Interactions in Systems
2.3.3 Prioritization and Focus
2.3.4 Trade-offs, Judgment and Balance in Resolution
2.4 ATTITUDES, THOUGHT AND LEARNING
2.4.1 Initiative and the Willingness to Make Decisions in the Face of Uncertainty
2.4.2 Perseverance, Urgency and Will to Deliver, Resourcefulness and Flexibility
2.4.3 Creative Thinking
2.4.4 Critical Thinking
2.4.5 Self-awareness, Metacognition and Knowledge Integration
2.4.6 Lifelong Learning and Educating
2.4.7 Time and Resource Management
2.5 ETHICS, EQUITY AND OTHER RESPONSIBILITIES
2.5.1 Ethics, Integrity and Social Responsibility
2.5.2 Professional Behavior
2.5.3 Proactive Vision and Intention in Life
2.5.4 Staying Current on the World of Engineering
2.5.5 Equity and Diversity
2.5.6 Trust and Loyalty

3 INTERPERSONAL SKILLS: TEAMWORK AND COMMUNICATION
3.1 TEAMWORK
3.1.1 Forming Effective Teams
3.1.2 Team Operation
3.1.3 Team Growth and Evolution
3.1.4 Team Leadership
3.1.5 Technical and Multidisciplinary Teaming
3.2 COMMUNICATIONS
3.2.1 Communications Strategy
3.2.2 Communications Structure
3.2.3 Written Communication
3.2.4 Electronic/Multimedia Communication
3.2.5 Graphical Communication
3.2.6 Oral Presentation
3.2.7 Inquiry, Listening and Dialog
3.2.8 Negotiation, Compromise and Conflict Resolution
3.2.9 Advocacy
3.2.10 Establishing Diverse Connections and Networking
3.3 COMMUNICATIONS IN FOREIGN LANGUAGES
3.3.1 Communications in English
3.3.2 Communications in Languages of Regional Nations
3.3.3 Communications in Other Languages

4 CONCEIVING, DESIGNING, IMPLEMENTING, AND OPERATING SYSTEMS IN THE ENTERPRISE, SOCIETAL AND ENVIRONMENTAL CONTEXT – THE INNOVATION PROCESS
4.1 EXTERNAL, SOCIETAL, AND ENVIRONMENTAL CONTEXT
4.1.1 Roles and Responsibility of Engineers
4.1.2 The Impact of Engineering on Society and the Environment
4.1.3 Society's Regulation of Engineering
4.1.4 The Historical and Cultural Context
4.1.5 Contemporary Issues and Values
4.1.6 Developing a Global Perspective
4.1.7 Sustainability and the Need for Sustainable Development
4.2 ENTERPRISE AND BUSINESS CONTEXT
4.2.1 Appreciating Different Enterprise Cultures
4.2.2 Enterprise Stakeholders, Strategy and Goals
4.2.3 Technical Entrepreneurship
4.2.4 Working in Organizations
4.2.5 Working in International Organizations
4.2.6 New Technology Development and Assessment
4.2.7 Engineering Project Finance and Economics
4.3 CONCEIVING, SYSTEMS ENGINEERING AND MANAGEMENT
4.3.1 Understanding Needs and Setting Goals
4.3.2 Defining Function, Concept and Architecture
4.3.3 System Engineering, Modeling and Interfaces
4.3.4 Development Project Management
4.4 DESIGNING
4.4.1 The Design Process
4.4.2 The Design Process Phasing and Approaches
4.4.3 Utilization of Knowledge in Design
4.4.4 Disciplinary Design
4.4.5 Multidisciplinary Design
4.4.6 Design for Sustainability, Safety, Aesthetics, Operability and other Objectives
4.5 IMPLEMENTING
4.5.1 Designing a Sustainable Implementation Process
4.5.2 Hardware Manufacturing Process
4.5.3 Software Implementing Process
4.5.4 Hardware Software Integration
4.5.5 Test, Verification, Validation, and Certification
4.5.6 Implementation Management
4.6 OPERATING
4.6.1 Designing and Optimizing Sustainable and Safe Operations
4.6.2 Training and Operations
4.6.3 Supporting the System Life Cycle
4.6.4 System Improvement and Evolution
4.6.5 Disposal and Life-End Issues
4.6.6 Operations Management
4.7 LEADING ENGINEERING ENDEAVORS
Creating a Purposeful Vision
4.7.1 Identifying the Issue, Problem or Paradox
4.7.2 Thinking Creatively and Communicating Possibilities
4.7.3 Defining the Solution
4.7.4 Creating New Solution Concepts
Delivering on the Vision
4.7.5 Building and Leading an Organization and Extended Organization
4.7.6 Planning and Managing a Project to Completion
4.7.7 Exercising Project/Solution Judgment and Critical Reasoning
4.7.8 Innovation – the Conception, Design and Introduction of New Goods and Services
4.7.9 Invention – the Development of New Devices, Materials or Processes that Enable New Goods and Services
4.7.10 Implementation and Operation – the Creation and Operation of the Goods and Services that will Deliver Value
4.8 ENTREPRENEURSHIP
4.8.1 Company Founding, Formulation, Leadership and Organization
4.8.2 Business Plan Development
4.8.3 Company Capitalization and Finances
4.8.4 Innovative Product Marketing
4.8.5 Conceiving Products and Services around New Technologies
4.8.6 The Innovation System, Networks, Infrastructure and Services
4.8.7 Building the Team and Initiating Engineering Processes
4.8.8 Managing Intellectual Property

SAMPLE STAKEHOLDER SURVEY AT MIT

Sample: 6 groups surveyed: 1st- and 4th-year students, alumni 25 years old, alumni 35 years old, faculty, leaders of industry

Question: For each attribute, please indicate which of the five levels of proficiency you desire in a graduating engineering student:

Scale:

1 To have experienced or been exposed to
2 To be able to participate in and contribute to
3 To be able to understand and explain
4 To be skilled in the practice or implementation of
5 To be able to lead or innovate in

PRIORITIZING LEARNING OUTCOMES

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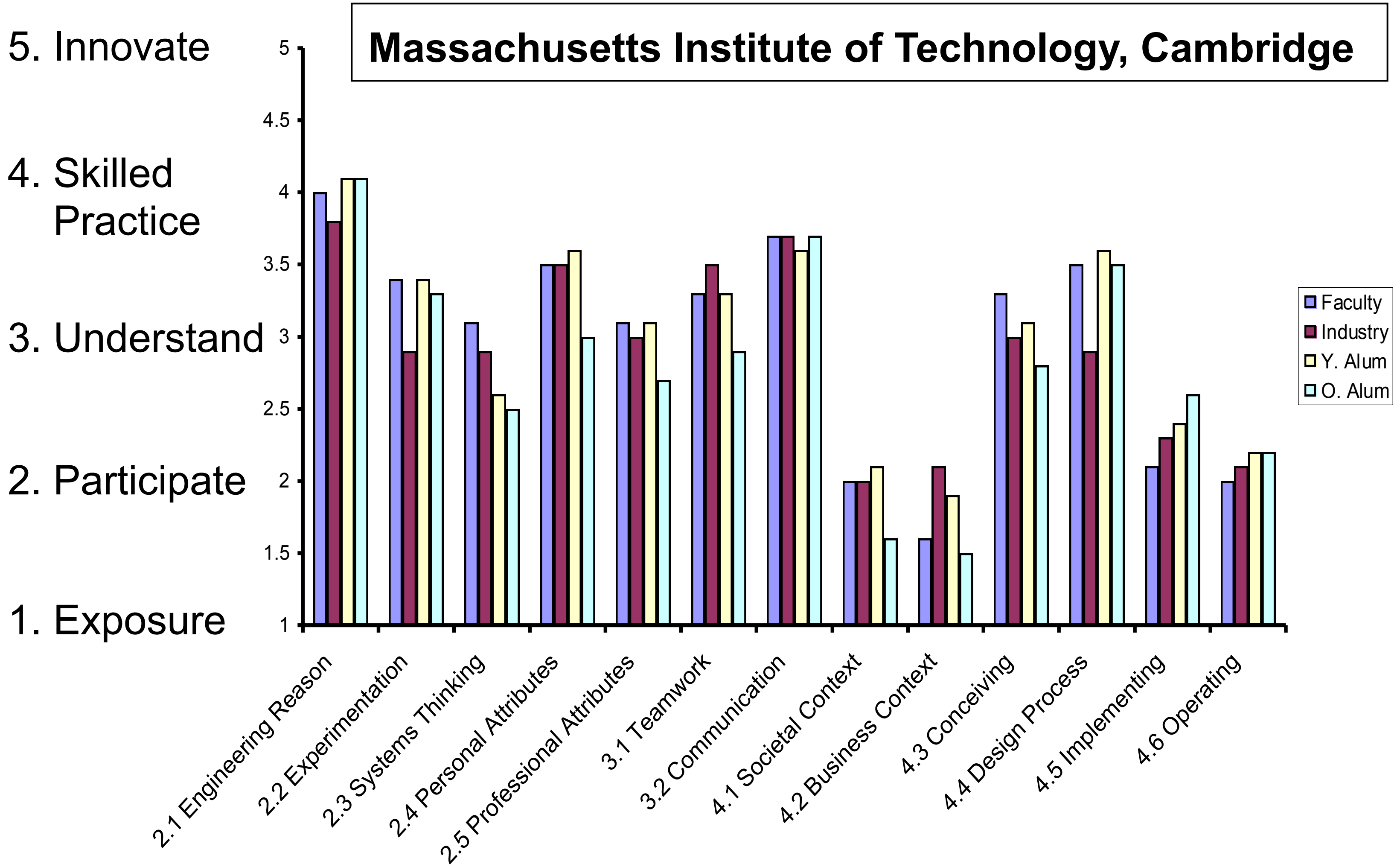


Analysis is rated highest but almost as high proficiency is needed in design, communication and teamwork

THE *CDIO SYLLABUS V 2.0* AS PROGRAM LEARNING OUTCOMES

1.0 Disciplinary Knowledge and Reasoning	1.1 1.2 1.3	Demonstrate a capacity to use the principles of the underlying sciences Apply the principles of fundamental engineering science Demonstrate a capacity to apply advanced engineering knowledge in the professional areas of engineering
2.0 Personal and Professional Skills and Attributes	2.1 2.2 2.3 2.4 2.5	Analyze and solve engineering problems Conduct investigations and experiments about engineering problems Think systemically Demonstrate personal and professional habits that contribute to successful engineering practice Demonstrate ethics, equity, and other responsibilities in engineering practice

THE *CDIO SYLLABUS V 2.0* AS PROGRAM LEARNING OUTCOMES (CONT.)

3.0 Interpersonal Skills	3.1	Lead and work in groups
	3.2	Communicate effectively
	3.3	Communicate effectively in one or more foreign languages.
4.0 CDIO	4.1	Recognize the importance of the social context in the practice of engineering
	4.2	Appreciate different enterprise cultures and work successfully in organizations
	4.3	Conceive and develop engineering systems
	4.4	Design complex engineering systems
	4.5	Implement processes of hardware and software and manage the implementation process
	4.6	Operate complex systems and processes and manage operations
	4.7	Lead engineering endeavors
	4.8	Demonstrate the skills of entrepreneurship

EXAMPLE OF FURTHER DETAILING (MECHANICAL ENGINEERING)

1.0 Disciplinary Knowledge and Reasoning	1.1.5	Use the Finite element method to solve partial differential equations
4.0 CDIO	4.3.7	Compare and evaluate different product suggestions based on function, environmental impact, production and finances

ACTIVITY: EXPECTED PROFICIENCY

Rate your own proficiency of each CDIO learning outcome at the x.x level.

Use:

- ❑ **the condensed version of the *CDIO Syllabus***
- ❑ **the five levels of proficiency:**
  1. **To have experienced or been exposed to**
  2. **To be able to participate in and contribute to**
  3. **To be able to understand and explain**
  4. **To be skilled in the practice or implementation of**
  5. **To be able to lead or innovate in**

3. **HOW CAN WE DO BETTER AT ASSURING THAT STUDENTS LEARN THESE SKILLS?**

   - ***Within the available student and faculty time, funding and other resources***

HOW CAN WE DO BETTER?

Retask current assets and resources in:

- **Curriculum**
- **Teaching and learning methods**
- **Design-implement experiences and engineering workspaces**
- **Learning assessment methods**
- **Faculty competence**
- **Program evaluation**

Evolve to a model in which these resources are better employed to promote student learning

DESIGN-IMPLEMENT EXPERIENCES

Design-implement experiences are instructional events in which learning occurs through the creation of a product, process, or system

- **They should be progressed to a state where:**
  - **they can demonstrate that they meet the requirements**
  - **potential improvements can be identified**
- **The level of complexity can vary from basic to advanced**
- **Provide the natural context in which to teach many CDIO syllabus skills (teamwork, communications, designing, implementing)**

DESIGN-BUILD PROJECT (EXAMPLES)

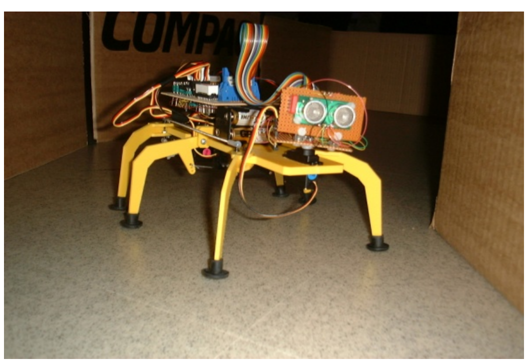
Solar-driven aircraft, KTH

”This course was the most rewarding that I have ever taken!!!”

”The Vehicle project created a surge for knowledge”

(KTH student)

Walking robot, LiU

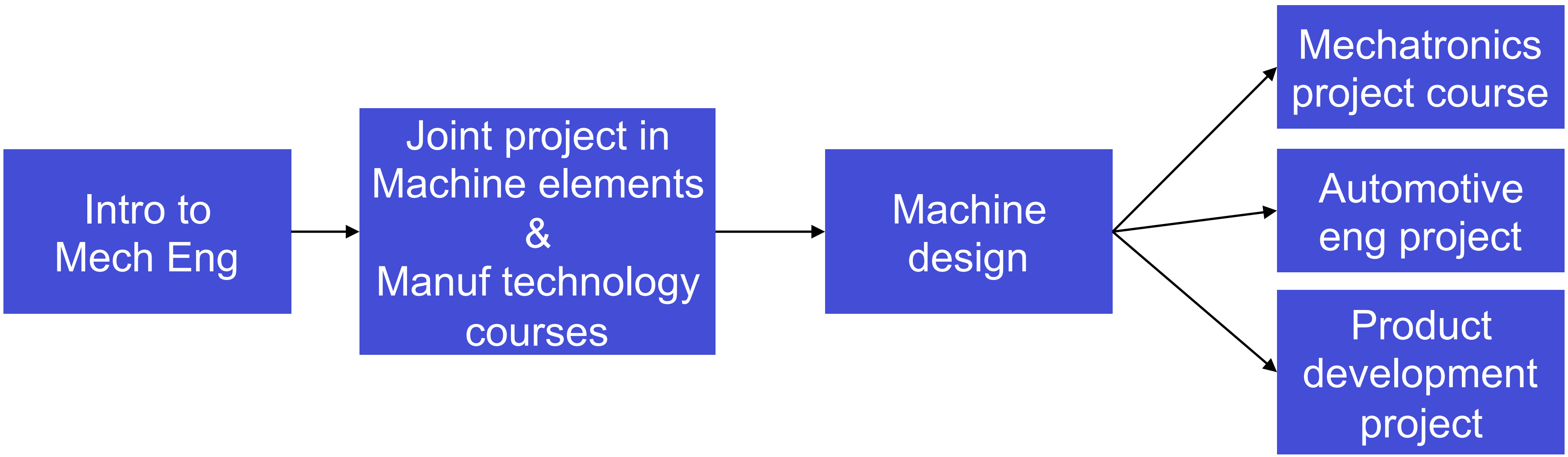


Formula Student, Chalmers

Nano satellites, MIT

THERE SHOULD BE MULTIPLE DESIGN–BUILD PROJECTS IN THE CURRICULUM

Year 1	Year 2	Year 3	Year 4



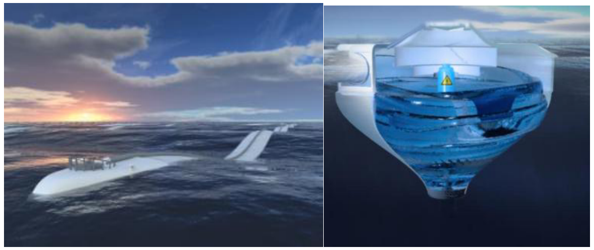
Year 1	Year 2	Year 3	Year 4
Creative, ”conceptual” design	Design for manufacturing	Redesign Multiple objectives	Creative design incl business aspects Cross-dept teams
Simple prototype Qualitative	More advanced prototype Some simulation Company is customer	Prototype as needed More simulation	Prototype Simulation as needed Company is customer

DESIGN-BUILD-TEST PROJECTS ADDRESS SUSTAINABLE INNOVATION

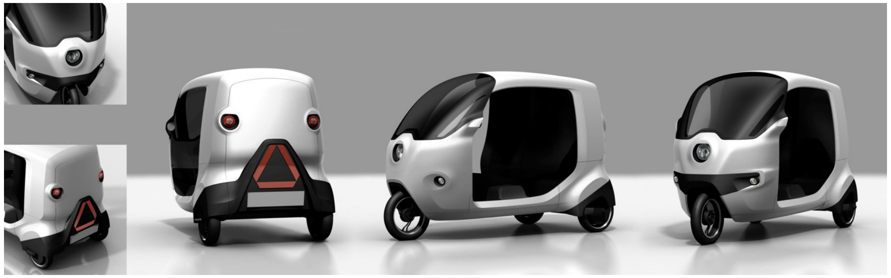
- **4th year Product development project course, interdisciplinary student teams**
- **Design-build and business development**
- **Collaboration with start ups and established firms**

Solar tracker actuator (SKF)

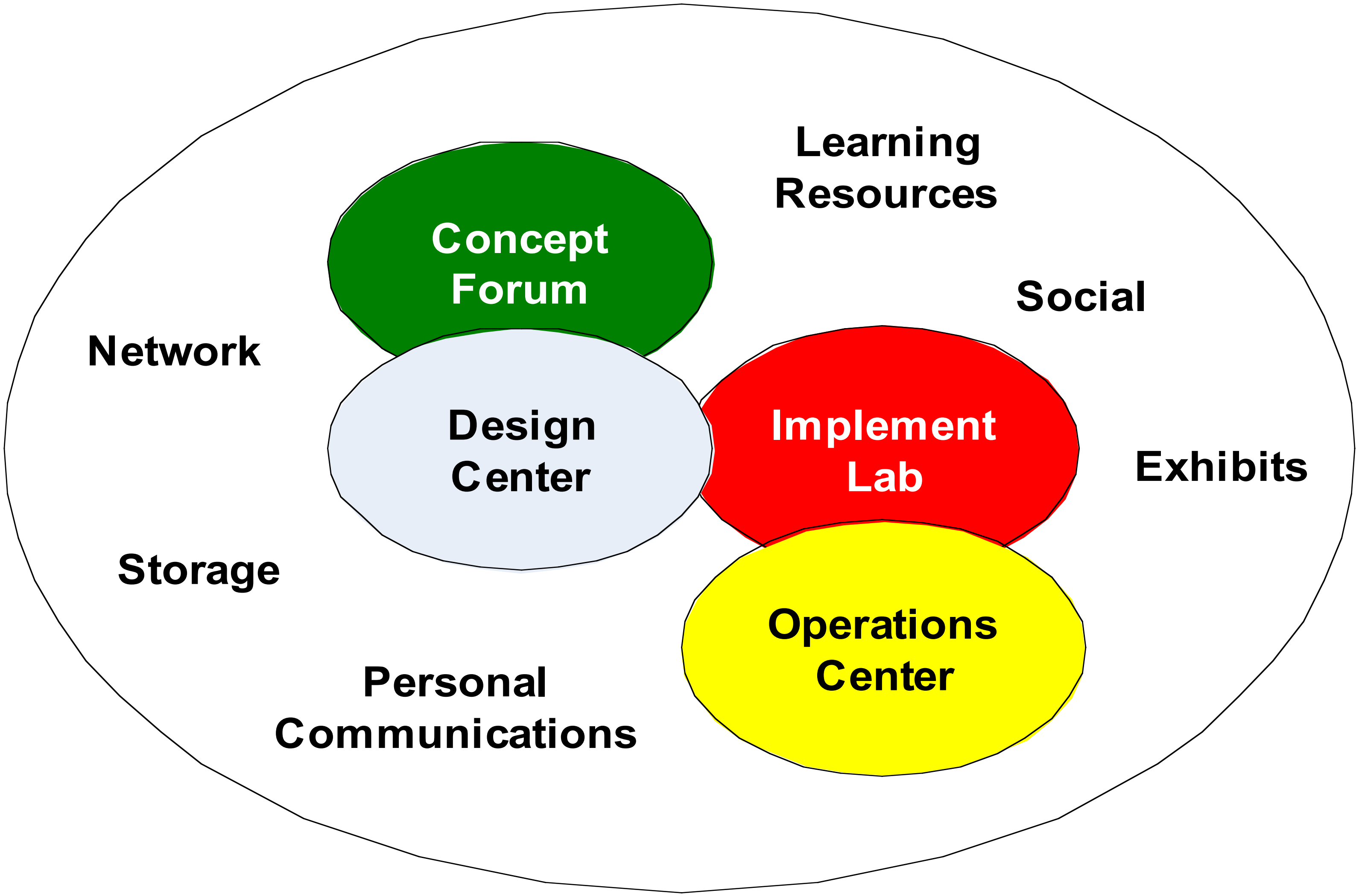
Wave energy (Vigor Wave)



Ultralight electric vehicle (CleanMotion)

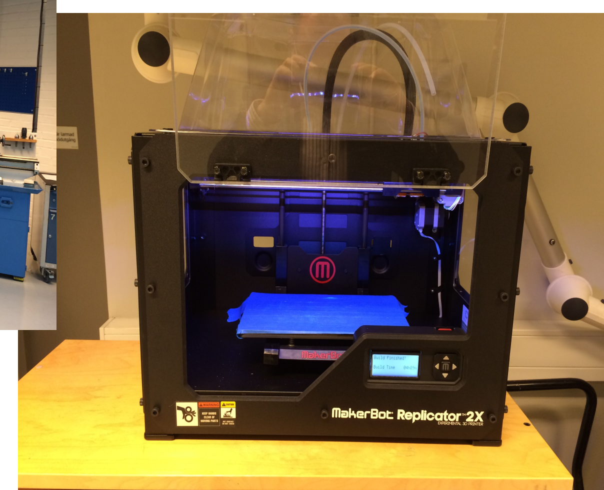


STUDENT WORKSPACES FOR CDIO



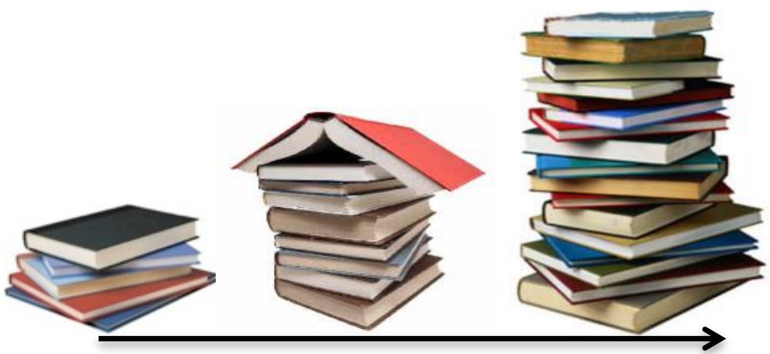
CDIO IMPLEMENTATION WORKSPACE – THE PROTOTYPING LABORATORY

- 450 m2 facility where students can build prototypes
- Metal machining, woodworking, rapid prototyping, welding, electronics, …
- Used in courses and projects from year 1 to master thesis projects



CDIO AIMS FOR CO-EVOLUTION OF KNOWLEDGE AND SKILLS

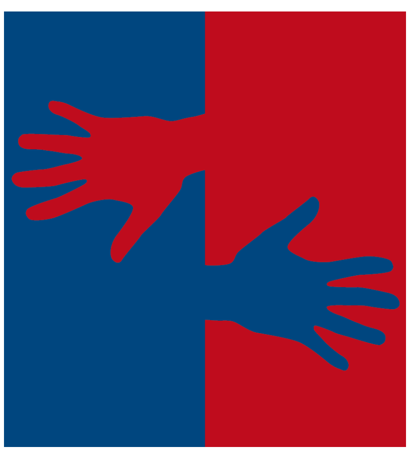
Integrated learning experiences develop **both** technical knowledge and “generic” skills (communication, teamwork, ethics, sustainability, etc)



Acquisition of technical knowledge

Development of generic skills

Knowledge & skills give each other meaning!



Source: Kristina Edström

INTEGRATION OF GENERIC (ENGINEERING) SKILLS - IMPLICATIONS

- **It's not about "soft skills"**

  Personal, interpersonal, product, process, and system building skills are **intrinsic to engineering** and we should recognise them as **engineering skills**.

- **It's not about "adding more content"**

  Students must be given opportunities to develop communication skills, teamwork skills, etc. This is best achieved through **practicing, reflecting, giving and receiving feedback** (rather than lecturing on psychological and social theory).

- **It's not about "wasting credits"**

  When students practice engineering skills they apply and express their technical knowledge. As they expose their understanding among peers, doing well will also matter more to them. Students will develop **deeper working knowledge**.

- **It's not about appending "skills modules"**

  Personal, interpersonal, product, process, and system building skills must be practiced and assessed **in the technical context**, it cannot be done separately.

EXAMPLE: COMMUNICATION SKILLS IN LIGHTWEIGHT DESIGN

Communication in lightweight design means being able to

- Use the technical concepts comfortably
- Discuss a problem of different levels
- Determine what factors are relevant to the situation
- Argue for, or against, conceptual ideas and solutions
- Develop ideas through discussion and collaborative sketching
- Explain technical matters to different audiences
- Show confidence in expressing oneself within the field

The skills are **embedded** in, and **inseparable** from, students' application of technical knowledge.

It is about educating engineers who can actually communicate about engineering!

The same interpretation should be made for teamwork, problem solving, professional ethics, and other engineering skills.

INTEGRATE THE CURRICULUM

An **integrated curriculum** has a systematic assignment of program outcomes to learning activities and features a explicit plan for progressive integration of generic skills

Planned learning sequence -- Vehicle Engineering -- KTH

CDIO Syllabus	Year 1		Year 2		Year 3	
3.2.3 Written communication	Introductory course	Mech I	Mech II	Thermo-dynamics	Control Theory	FEM in Engineering
3.3 Communi-cation in English	Math I	Math II	Solid Mechanics	Math III	Electrical Eng.	Bachelor Thesis
	Physics	Numerical Methods	Product development	Fluid Mechanics	Statistics	
				Sound and Vibrations	Signal Analysis	Opti-mization

ACTIVE AND EXPERIENTIAL LEARNING

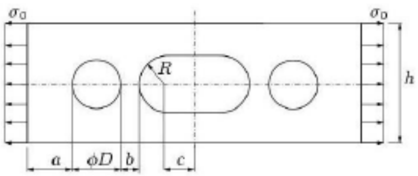
- **Reformed mathematics emphasizing simulations**
- **Motivate importance of mathematics and applied mechanics courses**
- **Realistic engineering problems**

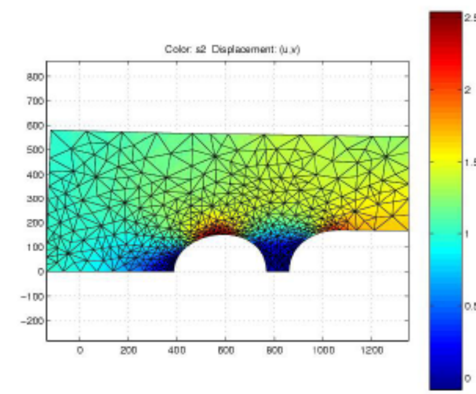
- **Working method based on modelling, simulation & analysis**
- **MATLAB programming**
- **Visualization of mechanical behaviour**

Year 1 lab example

Analys av plan elastiska skiva med fyra hål

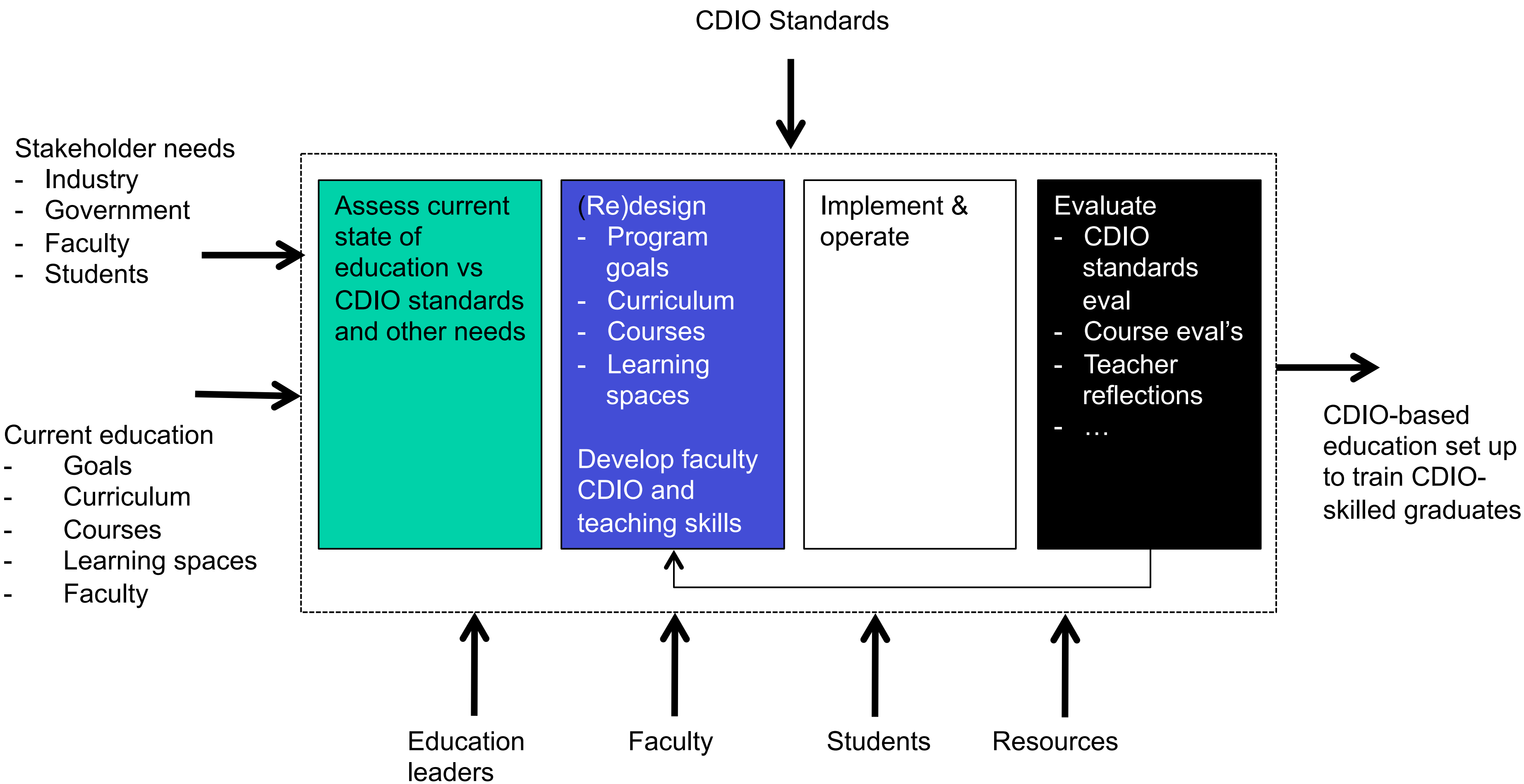
Beräkna spänningskoncentrationsfaktorn. Avgör om spänningshöjningarna vid hålen samverkar. Symmetrier skall utnyttjas.





HOW DO YOU DEVELOP A CDIO-BASED EDUCATIONAL PROGRAM?

CDIO-BASED EDUCATION DESIGN PROCESS



THE 12 CDIO STANDARDS – THE GUIDELINES FOR CDIO DEVELOPMENT

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Program focus 1,2,3

- CDIO as Context
- CDIO Syllabus Outcomes
- Integrated Curriculum

CDIO 4,5,6

- Introduction to Engineering
- Design-Build Experiences
- CDIO Workspaces

Teaching & Learning 7,8

- Integrated Learning Experiences
- Active Learning

Faculty development 9,10

- Enhancement of Faculty CDIO Skills
- Enhancement of Faculty Teaching Skills

Evaluation 11,12

- CDIO Skills Assessment
- CDIO Program Evaluation

See handbook pp 4-13

EFFECTIVE PRACTICE: THE CDIO STANDARDS

1. The Context
Adoption of the principle that product. Process, and system lifecycle development and deployment are the context for engineering education

2. Learning Outcomes
Specific, detailed learning outcomes for personal, interpersonal, and product,.process and system building skills, consistent with program goals and validated by program stakeholders

3. Integrated Curriculum
A curriculum designed with mutually supporting disciplinary subjects, with an explicit plan to integrate personal, interpersonal, and product, process, and system building skills

4. Introduction to Engineering
An introductory course that provides the framework for engineering practice in product. Process, and system building, and introduces essential personal and interpersonal skills

5. Design-Implement Experiences
A curriculum that includes two or more design-implement experiences, including one at a basic level and one at an advanced level

6. Engineering Workspaces
Workspaces and laboratories that support and encourage hands-on learning of product, process, and system building, disciplinary knowledge, and social learning

7. Integrated Learning Experiences
Integrated learning experiences that lead to the acquisition of disciplinary knowledge, as well as personal, interpersonal, and produc, process,t and system building skills

8. Active Learning
Teaching and learning based on active experiential learning methods

9. Enhancement of Faculty Skills Competence
Actions that enhance faculty competence in personal, interpersonal, and product and system building skills

10. Enhancement of Faculty Teaching Competence
Actions that enhance faculty competence in providing integrated learning experiences, in using active experiential learning methods, and in assessing student learning

11. Learning Assessment
Assessment of student learning in personal, interpersonal, and product, process, and system building skills, as well as in disciplinary knowledge

12. Program Evaluation
A system that evaluates programs against these 12 standards, and provides feedback to students, faculty, and other stakeholders for the purposes of continuous improvement

CDIO STANDARDS SELF-EVALUATION

- Guide to effective practice, based on:
  - Benchmarking
  - Our development
  - Scholarship on learning
- For each standard:
  - Assign a rating on a 0-5 rating scale is used to assess the fullfilment of the standard
  - Identify actions that would lead to higher rating
- Conduct the self-evaluations annually to track development and progress
- Used to:
  - Provide guidance for program design
  - Basis for periodic program self-evaluation
  - Provide framework for discussions and co-development

CONTENT OF THE STANDARDS

- For each of the 12 Standards, there is:
  - The Standard itself
  - A Description, Rationale
- A set of six ranking rubrics, both in a generic template, and specialized set for each of the 12 Standards
  - The rubrics suggest the evidence that would backup the ranking
- A separate document with sample evidence from our programs for information and reference

GENERIC RUBRIC

Rating	Criteria
5	Evidence related to the standard is regularly reviewed and used to make improvements
4	There is documented evidence of the full implementation and impact of the standard across program components and constituents
3	Implementation of the plan to address the standard is underway across the program components and constituent
2	There is a plan in place to address the standard
1	There is an awareness of need to adopt the standard and a process is in place to address it
0	There is no documented plan or activity related to the standard

CHALMERS MECHANICAL ENGINEERING – EVOLUTION OVER TIME

	Standard	2000	2003	2005	2008	2010
1	CDIO as context	2	2	4	4	4
2	CDIO syllabus outcomes	1	1	2	4	4
3	Integrated curriculum	2	2	3	4	4
4	Integration to engineering	3	4	4	4	4
5	Design-build experiences	1	3	4	4	4
6	CDIO workspaces	1	3	4	4	4
7	Integrated learning experiences	2	2	3	4	4
8	Active learning	1	1	3	3	4
9	Enhancement of faculty CDIO skills	1	1	2	2	2
10	Enhancement of faculty teaching skills	1	2	2	3	3
11	CDIO skills assessment	2	2	3	3	3
12	CDIO programme evaluation	1	2	3	4	4
Average		1.5	2.1	3.1	3.6	3.7

Note: These evaluations used a 0-4 rating scale

ELEMENTS IN THE CDIO EDUCATION DESIGN TOOLBOX

- The CDIO Syllabus
- The CDIO Standards

- Processes for setting program goals (learning outcomes), curriculum design, course design, education change implementation
- Guidelines for designing design-build experiences and learning workspaces, assessment schemes

- Start-Up Guidance
- Implementation Kit (I-Kit)
- Instructional Resource Materials (IRMs)

- 500+ papers on CDIO courses etc

- Available at CDIO.org

ACTIVITY: GROUP-WISE DISCUSSION

What CDIO elements do you already have in your programs?

What elements would be desirable to develop?

How could you carry out the implementation of CDIO elements

CDIO IS NOT A COOKIE CUTTER APPROACH

CDIO is a reference model, not a prescription

Everything has to be *translated-transformed* to fit the context and conditions of each university / program

Take what you want to use, transform it as you wish, give it a new name

CDIO provides a toolbox for working through the process

Local faculty ownership is key

TO SUMMARIZE: THE MAIN GOALS OF ENGINEERING EDUCATION

To educate students who are able to:

- **Master a deeper working knowledge of the technical fundamentals**
- **Lead in the creation and operation of new products, processes, and systems**
- **Understand the importance and strategic impact of research and technological development on society**

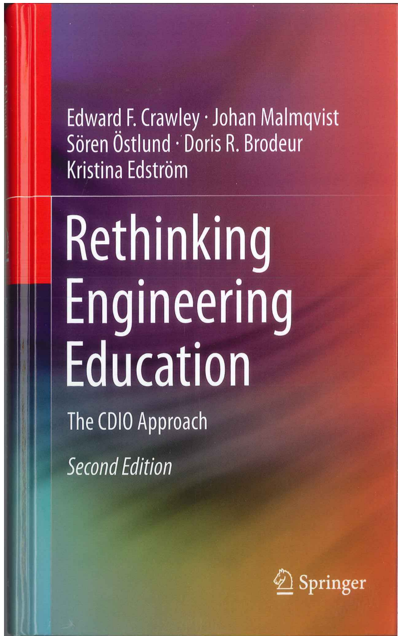
CONCLUDING REMARKS – WHAT IS CDIO?

- **An idea of what engineering students should learn: To become "Engineers who can engineer"**

- **A methodology for engineering education reform: The CDIO Syllabus and the 12 CDIO Standards**

- **A community: The CDIO Initiative with 120 universities as members**

- **To learn more, visit www.cdio.org or read *Rethinking Engineering Education: The CDIO Approach, 2nd ed* by Crawley, Malmqvist, Östlund, Brodeur & Edström, 2014**



Thank you for listening!

Any questions or comments?